May 30

Physical & Applied Sci. Serials

Thirty-eighth Annual Report of the Savilian Professor of Astronomy to the Visitors of the University Observatory for 1912–13.

BOARD OF VISITORS, 1913.

THE VICE-CHANCELLOR (Charles Buller Heberden, M.A., Hon. D.C.L., Principal of Brasenose).
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THE DIRECTOR OF THE CAMBRIDGE OBSERVATORY (Sir R. S. Ball, M.A., LL.D., F.R.S.).
THE RADCLIFFE OBSERVER (A. A. Rambaut, M.A., D.Sc., F.R.S.).
EDWIN B. ELLIOTT, M.A., F.R.S., Fellow of Magdalen. } For ten years until
CHARLES LEUDESDORF, M.A., Fellow of Pembroke. } Nov. 10, 1915.
WILLIAM ESSON, M.A., F.R.S., Fellow of New College. } For ten years until
SIR W. H. M. CHRISTIE, K.C.B., Hon. D.Sc., F.R.S. } Nov. 10, 1920.

THE Report here presented refers to the period from May 1, 1912, to April 10, 1913, and exhibits the state of the Observatory on the last-named day.

As a brief summary it may be remarked that the chief work of the year has been the examination and printing of the Cambridge Ledgers, with a discussion of the magnitude equation and its changes: for which the work on differential star places has been temporarily put aside. Two zones of the Vatican plates (+64° and +63°) have been completely reduced under the general superintendence of the Observatory. We are at last able to report the large dome watertight.

I. Buildings and Grounds.

The two domes were painted last September. It is hoped that the constant trouble with the large dome has at last been terminated by covering all the joints of the paper and iron with a broad strip of thick linen. The suggestion is due to Messrs. Thomas and Son, who had already tried the method on the smaller dome, and our hearty thanks are due to them not only for the suggestion but for the success with which they have carried it out. Not a drop of rain has come through into the dome in any of the showers and storms that have occurred since the remedy was applied last September. The outside appearance may not be so neat, but the instruments and rooms below are now freed from sudden deluges. A word of explanation may be added as to the difficulty of avoiding these under previous conditions. If there is any one in the Observatory, it is a simple matter to go into the dome when rain begins and arrange a series of buckets under the leaks: and if the dome were a fixed roof, these would probably suffice for other occasions. But the dome is liable to be rotated to any azimuth in the course of using the telescope, and it is impracticable to move the buckets with it. Hence a storm during the night, or on Sunday, generally brought disaster. This particular danger has now been removed, but so long as there is no residence at the Observatory it is impossible to prevent others. On July 23 last, during Mr. Mullis's annual vacation and during the luncheon hour, a sudden heavy storm choked a drain and then forced its way up a waste pipe into the basement. Miss Bellamy, who returned hastily to see whether a window might have been left open, found the basement flooded to a depth of 2 or 3 inches. It was some little time before she could find the source of the trouble and remove it, and no assistance was near. It took three of us some hours to bale out the basement, and some days for it to get thoroughly dry. The University may perhaps be reminded that there is no Observatory of the same class in the world where there are these discomforts and risks, entailed by non-residence.

Now that the dome is watertight we have ventured to renew the matting. The old matting has been in use since 1875, and was much stained by the leakages.

Brass picture-rods have been fixed in the Lecture room.

II. Library and Movable Property.

During the year 282 sheets of the Astrographic Chart have been received, of which 143 are of regions South of the Equator. We now have altogether 3,181, of which 820 are South of the Equator. The process of cutting down the sheets for storing in the new case has proceeded steadily, but it is necessary to cut each sheet separately, and this takes time.

The waste margins have been found very useful for making various card catalogues, the irregularity of the cards being found an advantage in handling.

The binding of Observatory publications is up to date.

The card catalogue of the bound pamphlets is complete for 70 of the 170 volumes.

Mr. Mullis has extended the shelf-room by some 30 feet (adding incidentally two new cupboards) which will meet our needs for a few years, but we are approaching the end of our space.

The late Mr. S. A. Saunder, whose sudden death cut short his plans for settling in Oxford for astronomical work, with the University Observatory as headquarters, left as a legacy to the Director his books, maps, computations, and negatives relating to the Moon. This has been interpreted as a legacy to the Observatory.

The Radcliffe Observer has kindly supplied us with a copy of Bradley's *Greenwich Observations* (1750–1762) and with some of his duplicates which fill gaps in our serials ; and we have been able to make some return in the latter respect.

A number of new slides have been made for lecture purposes.

III. Instruments.

The chronograph kindly lent by the Astronomer Royal has been returned to Greenwich.

An enlarging apparatus has been arranged, with special reference to the maps of the Moon prepared by the Committee on Lunar Nomenclature of the International Association of Academies, of which the Director was appointed Chairman in 1910.

The telescopes are in good order.

IV. Observations and Reductions.

The photographic observation of zone + 29° by the differential method of composite plates is proceeding, three-quarters of the zone being now measured, and the straightforward reductions complete for about half of this. The final stages of critical discussion have been delayed by the work on the Cambridge Ledgers, which it was determined to complete forthwith in order that they might be compared with the new results. Such a comparison required that the Ledgers, in which are collected the corrections to the Cambridge meridian observations from all the separate plates taken at Oxford, should be—

(*a*) Revised for the elimination of casual errors. This hunting down of stray mistakes in a catalogue of some 15,000 stars takes some time. It has been completed during the past year, and the mean results printed as Part I of our Volume VIII.

(*b*) Discussed for magnitude equation. It has for some time been realized that the chief errors affecting the Cambridge meridian observations (of date about 1880) as used by us at Oxford about 1900, are *not* due to the movements of the stars in 20 years, as has been hastily assumed in proposals to repeat these meridian observations: the chief errors are due to " magnitude equation ", i. e. the systematic error of observation which depends on the brightness of the particular star observed. But it was not realized until recently how serious had been the *changes* in this error. The Cambridge observations were nearly all made by the same two observers, one at the telescope and the other at the circle. It was supposed that their habits of observation, however peculiar, would remain sensibly constant. The first suspicion of the contrary was aroused by the discussion of the first composite plate; and the extended investigation which has been made during the past year shows that the changes were very serious. To be exhaustive, the discussion should have gone back to the original observations; but this was too great a labour for us to undertake here, even if we had had full facilities for it. As a compromise, the mean date of observation as given in the Catalogue was used, a procedure which tends to smooth down the irregularities: and the discussion by this plan is being printed. As a brief summary indicating the magnitude of the errors, the following mean values of Δx for four periods into which the observations roughly sort themselves may be given.

CORRECTIONS TO CAMBRIDGE R.A.'S IN UNITS OF $\cdot 0001 = 0''\cdot 03$.

Period	Cambridge Magnitude						
	6·0	7·9	8·6	9·0	9·2	9·4	9·5
1872–78	+45	+28	+20	+4	−8	−21	−19
1879–85	+42	+25	+12	−5	−17	−42	−57
1886–92	+45	+10	−5	−17	−36	−45	−44
1893–end (few obsns.)	—	+23	+10	+30	−20	+10	+58

It will be seen that the observations of faint stars are affected by considerable and rapidly changing errors. Now the great majority of the stars used in determining "constants of the plates" are faint, especially in the regions remote from the Milky Way where stars are not very numerous. The difficulty of obtaining a proper groundwork for our plates is not that of proper motion (which is very small for faint stars), but that of magnitude equation (which is large for faint stars, and apparently changeable). Similar errors have been found by Professor Arthur Searle at Harvard, and it is difficult to believe that they are not general, though when many observers are mixed together they may be harder to identify. The conclusion is that places for the reference stars suitable for finding constants for the photographic plates cannot be obtained without even greater labour and care than has already been expended on them; and attention is thus again directed to the advisability of using some photographic method.

As mentioned in the last Report, the general superintendence of the reductions of the Vatican plates has been undertaken at this Observatory. A sum of £150 (of which about half has been expended) has been provided by the Vatican, in addition to Mr. Lindemann's benefaction, for the expenses of computing. Zones +64° and +63° are now completely reduced, with the exception of one plate in zone +63° in which the reductions showed some error. This plate has since been repeated at Rome and is being measured. The printing of zone +64° is being begun at Rome. Tables of reduction for the remaining zones have also been made, and the whole of the places of the Helsingfors Catalogue (1875·0) have been brought down to 1900·0. Ledgers have been prepared for the Helsingfors stars, and the entry of the residuals for zones +64° and +63°, as well as those for zone +65° kindly furnished by the Astronomer Royal, has led to the detection of a few chance errors, not only in the measures, but in the Helsingfors Catalogue, and even, in two cases, in the Greenwich results. It was a great solace to the ladies (of a religious order) who are making the measures to find that the mistakes were not all on their part.

V. Printing and Publication of Results.

As above mentioned, Part I of Vol. VIII, containing the mean corrections to the Cambridge Meridian Observations, and a discussion of the magnitude equation, is nearly printed, and will be distributed shortly.

The usual distribution of reprints of papers by members of the staff to about 170 institutions and persons was made during the year.

By the kindness of Bodley's Librarian, the leave for the storage of 100 copies of each of our seven published volumes, which expired in December last, has been renewed till Dec. 1918, and has been extended to include another 700 volumes. This will still leave a large stock at the Observatory, but removes all immediate difficulties.

The following papers have emanated from the Observatory during the year:—

"On the Motions of the Brighter Stars of Class A in relation to the Milky Way." By H. C. Plummer. (Forms the *Lick Observatory Bulletin*, No. 212.)

"On the Motions and Distances of certain Stars of the Types B8 and B9." By H. C. Plummer, *Mon. Not.*, LXXII, p. 555 (May, 1912).

"A Proposal for the Comparison of the Stellar Magnitude Scales of the different Observatories taking part in the Astrographic Catalogue." Third Note: "The Algiers Magnitudes." By H. H. Turner, *Mon. Not.*, LXXII, p. 700 (June, 1912).

"On Double Lines in Periodograms." By H. H. Turner (International Congress of Mathematicians, August, 1912).

"Note on the Cambridge Magnitude Equation." By F. A. Bellamy, *Mon. Not.*, LXXIII, p. 88 (Dec. 1912).

"Note on a New Similarity between the Variations of S. Persei and of Sun-spots." By H. H. Turner, *Mon. Not.*, LXXIII, p. 116 (Dec. 1912).

"Baxendell's Observations of Variable Stars." No. 1. R. Arietis. Edited by H. H. Turner, *Mon. Not.*, LXXIII, p. 124.

"Note on the Possibility of Refraction by the Sun's Atmosphere." Papers of the I. U. S. R., No. VIII. By R. S. Capon, *Mon. Not.*, LXXXIII (March, 1912).

VI. Lectures and Visitors.

The course of Lectures by the Professor on the Astronomy required for the Mathematical Final Schools was delivered, as usual, in the Michaelmas and Hilary Terms. The services of Mr. R. S. Capon were retained in the Michaelmas Term for the practical instruction hitherto given by Mr. Plummer, but there were no applicants this year.

A lecture on Greek Astronomy was delivered last Summer Term as part of the course arranged by Professor Murray.

Three lectures to Engineering Students were delivered in June, at the request of Professor Jenkin.

Three lectures were delivered at the Royal Institution in February, on "The Movements of the Stars".

Last summer we had the pleasure of seeing M. Baillaud, Director of the Paris Observatory, his architect, and the Comte de la Baume Pluvinel, who were on a tour of inspection of observatories with a view to possible developments of the Paris Observatory.

Mr. Shin Hirayama of the Tokio Observatory, and Professor Milne's assistants, Mr. Burgess and Mr. Hirota, also paid us visits.

Several parties of Workers from the Oxford Summer School were shown the Observatory, and given brief lectures illustrated by lantern-slides.

VII. Personal Establishment.

Mr. H. C. Plummer was appointed Royal Astronomer for Ireland while the last report was in the press, and left this Observatory in June. His memoir on the parallaxes of stars observed at the Lick Observatory for motion in the line of sight was published as L. O. B. No. 212 (see § V), and he has followed it with two important papers on the same subject since his removal to Dunsink. It is pleasant to remember that this investigation, the complete development of which at Dunsink may be awaited with great interest, was set on a firm footing here, at the close of a courageous and successful decade of service.

Mr. Bellamy has worked untiringly at the Cambridge Ledgers, and it is due chiefly to his devotion that the examination and printing are already complete.

The services of Miss E. F. Bellamy were recognized by the Board at its last meeting by a definite appointment on the staff, and I have pleasure in reporting that she has justified the new departure. An instance of her ungrudging care has been mentioned already in § I.

Mr. S. C. Cook, after some years of service as computer, leaves us at the end of April for an engagement at the University Press, where his father has been a reader for many years.

Mr. J. Mullis has discharged his duties with his customary zeal, in spite of several slight attacks of illness.

The vacancy caused by Mr. Plummer's appointment has not been filled at present.

H. H. TURNER.

UNIVERSITY OBSERVATORY,
April 11, 1913.